AGRICULTURE AND LAND USE AS AFFECTED BY STRIP MINING OF COAL IN EASTERN OHIO

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INTRODUCTION

This study was made to determine the influence which strip mining of coal may have on agriculture and other land uses in eastern Ohio. Information is needed to determine the probable future expansion of strip mining; how much area will eventually be torn up and how much additional land adjacent to the strip mines will be affected. Will sufficient land be disturbed to have a permanently depressing influence on the economic and social welfare of rural communities? How can these lands be best utilized after the mining operations are completed? Can strip-mine lands be reclaimed and fitted for some economic use and at what cost? Questions such as the above need to be weighed against the fact that strip mining converts a natural resource into a large amount of usable wealth and provides employment during the continuance of operations.

The Development of Strip Mining and the Process Described

During the year 1913 and shortly thereafter strip mining of coal was inaugurated on a commercial scale in several Ohio counties. Where the overburden of earth was only a few feet deep it was found that steam shovels could recover the coal cheaper and faster than the conventional process of drifting an entry into the side of a hill or sinking a shaft to the vein of coal.

In the process of strip mining the overburden of earth is removed from the seam of coal or other mineral and deposited to one side. This is accomplished by means of power equipment, usually shovels operated by steam, internal-combustion engines, or electricity. The largest electric shovels operated in eastern Ohio have a 90 foot boom and can remove up to 70 feet or more of overburden cutting a furrow about 75 feet wide. Starting on a slope where the coal outcrops or is near the surface, a shovel works back and forth on a hillside until the overburden becomes too thick for profitable operation; or, if the coal vein is not too deep an entire hilltop may be mined out but this is the exception rather than the rule for it often occurs on hilly terrain that only one, two or three cuts can be made profitably.

1/ The authors express their appreciation to the following people: the County agents, County officials, County A.C.P. staffs, and Conservation Commission officials in the area studied for valuable advice, assistance, and cooperation in this study; Mr. R. R. Paton, Dept. of Forestry, Ohio Experiment Station, for assistance in the field and preparation of a section of this publication; Dr. D. R. Dodd, Pasture Specialist, Agricultural Extension Service, Ohio State University; Mr. Wilber Stout, State Geologist; and Dr. L. E. Hicks, Director, Cooperative Wildlife Research Station for advice and assistance; and Mr. Donald E. Flory for assistance in the collecting and assembling of data.

In contrast, an occasional gently rolling or level area is strip mined in a solid block. Typically, eastern Ohio strip-mine operations recover the coal from about one-fourth of the land area of individual tracts, the remaining area either being below the coal or having too much overburden above the coal for profitable strip mining. More land is ruined for agricultural use than is strip mined; spoil banks and mine pits combined occupy about one-third of the area of the typical tracts. As a general rule, under prevailing methods, about 13 feet of overburden can be removed profitably to strip mine one foot of coal. Of course this varies with the character of the overburden but in general few coal seams in Ohio are sufficiently thick to encourage strip mining at present to a depth of more than 65 feet; i.e. five feet of coal.

Disposal of the overburden is a problem in strip mining because the volume of earth when excavated is so much greater than the original volume. As a result the spoil banks cover more than the surface actually mined. When large shovels are used to capacity the spoil-bank ridges may stand 20 to 30 feet or more higher than the original terrain and the slopes will be as steep as the earth will stick. This means that the sides of spoil banks have a slope ranging from 40 to 100 percent with an average of about 60 percent. 1/ Future use of spoil banks is limited by the steepness of these slopes even if other limiting factors were not present. On unmined land a 30 to 40 percent slope is considered very steep for pasture, in fact too steep to work over profitably with any kind of implements for pasture improvement or maintenance.

A completed strip-mine operation leaves the earth as if furrowed by a huge plow which has turned the earth upside down to a depth of 10 to 70 feet leaving a final furrow, "the pit," on the unmined side of which stands a vertical precipice called the "high bank."

A simple illustration of a fairly typical eastern Ohio strip mine is given in Figure 1, page 3.

Before taking up further description of the physical features and uses of strip-mined lands it is desirable to present some information on the past, present, and probable future extent of strip-mining operations.

The Extent of Strip Mining in Ohio

At some time or other in the past 26 years, coal has been strip mined on a commercial scale in 24 Ohio counties. Of all coal mined in Ohio by all methods, 19 percent was strip mined in 1939 as contrasted with 15 percent in 1927, - the next highest year, 8 percent in 1920 and less than one percent in 1914. Production has fluctuated widely from year to year, but the trend since 1934 indicates an expansion in strip mining both in total production and in relation to other methods of mining, Table 1, page 4. An estimated 9,000 acres of Ohio coal have been mined by the stripping method. Approximately 700 acres were stripped in 1939.

1/ On a 100 percent slope, a vertical rise of 100 feet is associated with 100 feet of change in horizontal distance; a 50 percent slope has a vertical rise of one hundred feet for each 200 feet of change in horizontal distance.

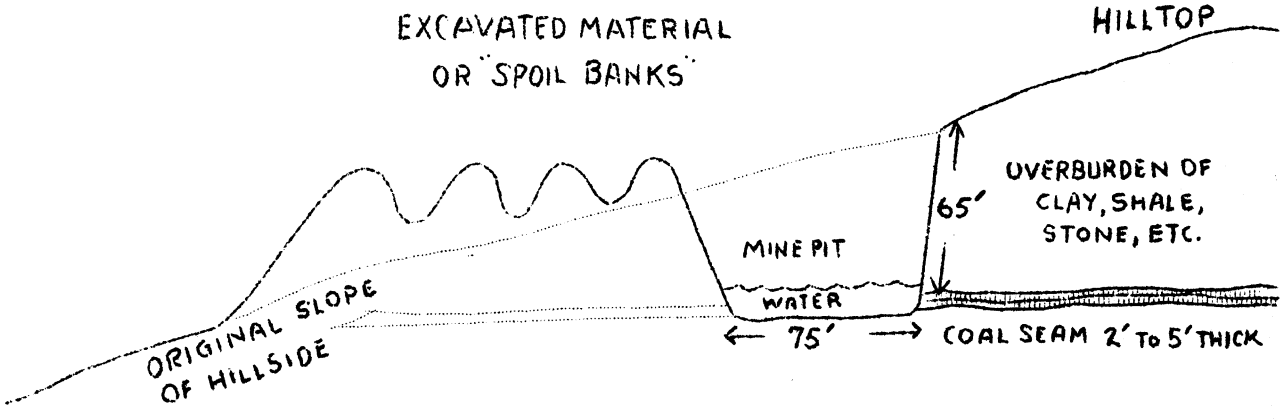


FIGURE 1.- CROSS-SECTION OF AN ABANDONED STRIP MINE.

Note: Under usual circumstances, 13 feet of overburden can be removed profitably to mine one foot of coal. Because few coal veins in eastern Ohio exceed 5 feet in thickness it is exceptional to find more than 65 feet of overburden removed by strip mining. Disposal of a greater depth of material is difficult. After the strip mine is abandoned, the pit, formed by the last cut, often fills with water making a long narrow lake which may be stocked successfully with fish, provided that the water is not toxic with minerals.

Table 1.- SUMMARY OF STRIP-COAL MINING IN OHIO, 1914-1939

Year	Number of Strip Mines 1/	Average Number of Employees 1/	Number of Counties Reporting Strip-Coal Mining	Strip-Coal Production (tons)	Percentage of Total Production of Ohio Coal	Estimated Acres Mined 2/
1914			2	141,446	0.8	26
1915			2	291,734	1.3	53
1916			3	533,153	1.5	97
1917			11	1,225,967	3.0	223
1918		1819	10	2,798,924	5.7	509
1919		1608	9	1,848,445	5.3	336
1920		2410	11	3,658,773	8.1	665
1921		1541	11	1,460,092	4.5	265
1922	44	2319	9	3,121,173	11.3	567
1923	48	2409	7	2,944,686	7.2	535
1924	38	1512	10	2,407,935	8.0	438
1925	31	1266	9	2,601,379	9.4	473
1926	17	1306	9	2,465,308	8.8	448
1927		1214	9	2,386,879	15.1	434
1928		684	6	2,036,999	13.9	370
1929		739	7	1,779,147	7.7	323
1930	20	443	8	1,154,939	5.2	210
1931		319	10	949,745	4.7	173
1932	16	277	6	790,739	5.6	144
1933	30	394	13	1,008,599	5.1	183
1934	36	733	14	1,141,453	5.6	208
1935	44	935	14	2,054,781	9.7	374
1936	59	923	16	2,342,000	10.0	426
1937	65	807	15	2,236,490	9.1	407
1938	76	848	17	2,399,390	13.1	436
1939	99		18	3,759,482	19.1	684

Source: Ohio Department of Industrial Relations.

1/ Data not available for years not shown.
2/ Based on an estimated average recovery of 5,500 tons of coal per acre.

The counties which lead in 1939 in the production of coal by strip mining are as follows, the highest first: Jefferson, Harrison, Stark, Columbiana, Mahoning, Tuscarawas, and Carroll. Jefferson produced 1,242,348 tons, one-third of all coal strip mined in Ohio in 1939; Harrison, one-half as much as Jefferson; Carroll, the seventh county, produced 117,064 tons. Ten percent of the total was produced in 11 other counties.

In brief, the concentration of strip mining is in the seven above mentioned counties which constitute a solid block of territory. Recent expansion in production is greatest in Stark, Columbiana, Mahoning and Tuscarawas.

As is indicated in Table 1, the number of strip mines in operation has been increasing in recent years; 99 in 1939 as compared with only 16 in 1932, and 44 in 1922. The number of persons employed in strip mining is relatively small, averaging less than 1,000 each year since 1927. Strip-mine production of coal in individual counties, by years, is shown in appendix A.

THE AREA OWNED AND LEASED FOR MINING PURPOSES

An important question is - how much area will eventually be strip mined? If the area is very limited no great concern need be felt about the eventual effects on the communities where the land is being torn up. On the other hand, if strip-mined lands will eventually constitute large blocks of territory, it is desirable to inquire where and how much area will be affected? With the above thought in mind, an attempt has been made in this study to determine the area owned and leased for mining purposes in the six counties where strip mining is most important.

Prevailing practices as to property-right arrangements for coal mining are of three kinds: (1) The company or persons may purchase the land in fee simple; (2) The coal alone may be purchased and the surface rights not transferred; (3) A royalty of an agreed sum, usually designated in cents per ton, may be paid as the coal is mined according to the terms of a lease. In Harrison and Jefferson counties the most frequent practice is purchase in fee simple by the mining company when the coal is to be stripped. In all other counties, with the possible exception of Tuscarawas, strip mining is nearly always on a royalty basis, presumably because the strippable coal is usually mined in small blocks and because the unsteady veins of coal may not produce according to preliminary expectations. Separately-owned mineral rights apply almost entirely to land where the coal is secured by shaft or drift mining rather than by stripping, it being recognized that the stripping process practically terminates the use of the surface for all conventional uses whereas other methods of mining have only a minor influence on the surface of the land.

The location of strip mining is so inextricably mixed with other modes of mining in most areas that the effects of one cannot be distinctly separated from the effects of the other. The point is illustrated by the maps, which have been prepared to show the location of strip-mine leases, and other lands leased and owned by mining companies. It is impossible to determine whether lands owned by mining companies will be stripped or deep mined.

In the six counties, Harrison, Jefferson, Columbiana, Stark, Mahoning and Tuscarawas, a total of more than 20,000 acres have been leased for strip mining in the past twenty years as compared with 66,000 acres leased for drift or shaft mining. Over 41,000 acres are now owned in fee simple by coal mining companies. In addition to the above acreage, separately-owned mineral rights covered 130,000 acres of coal in 1935 as compared with 150,000 acres in 1925.

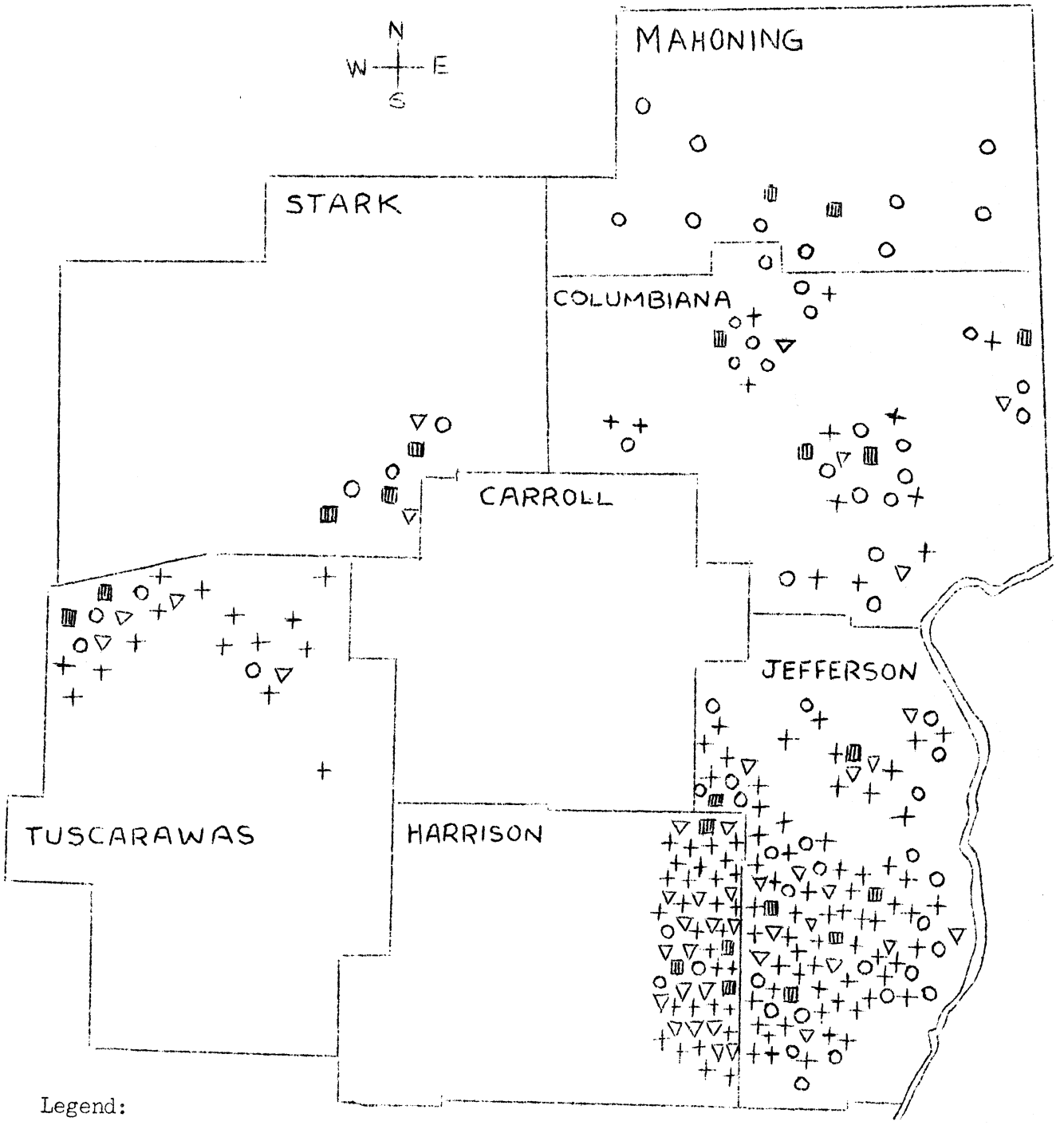
All told, coal mining operations have been contemplated on or under 250,000 acres in these six counties in the past 20 years. This is approximately 13 percent of the total land area of these counties. Leases alone for strip mining purposes cover one percent of the land area and land purchased in fee simple for strip mining an estimated additional one percent.

Table 2.- LAND OWNED AND LEASED FOR COAL MINING PURPOSES IN SIX EASTERN OHIO COUNTIES

	Owned (acres)	Strip-mine leases (acres)	Deep-mine leases (acres)	Separately-owned mineral rights (acres)	Total (acres)
Columbiana	3,785	4,272	20,110	12,716	40,893
Harrison	18,250 1/	3,855 1/	2,831 1/	30,059 1/	54,995
Jefferson	14,157	5,744	25,764	65,230	110,895
Mahoning	65	2,021	10,738	** 3/	12,824
Stark	1,509	3,199	3,449	** 3/	8,157
Tuscarawas	4,030 2/	1,573	3,997	14,583	24,183
Total	41,796	20,664	66,889	122,588	251,937

1/ In three townships which contain nearly all strip mines in Harrison County; in the entire county separately-owned mineral rights applied to 36,984 acres in 1935.
2/ Estimated.
3/ None listed for taxation.
Source: Public records.

Only about one-fourth of the area of the average tract is strip mined. On the assumption that this proportion would hold on all lands owned or leased for stripping in the six counties, eventually an estimated minimum of 13,000 and a maximum of 18,000 acres will be strip mined, of which 7,800 acres have already been mined out in the six counties.



Legend:

▭ = 1,000 acres leased for strip mining.
○ = 1,000 acres leased for deep mining.
△ = 1,000 acres owned by coal companies.
\+ = 1,000 acres separately-owned mineral rights.

FIGURE 2.- GENERAL LOCATION OF LANDS OWNED OR LEASED FOR COAL MINING PURPOSES IN SIX EASTERN OHIO COUNTIES.
Data covers three eastern townships only in Harrison County.
See Figures 3 to 7 for actual location of tracts in individual counties.
Source: Public Records.

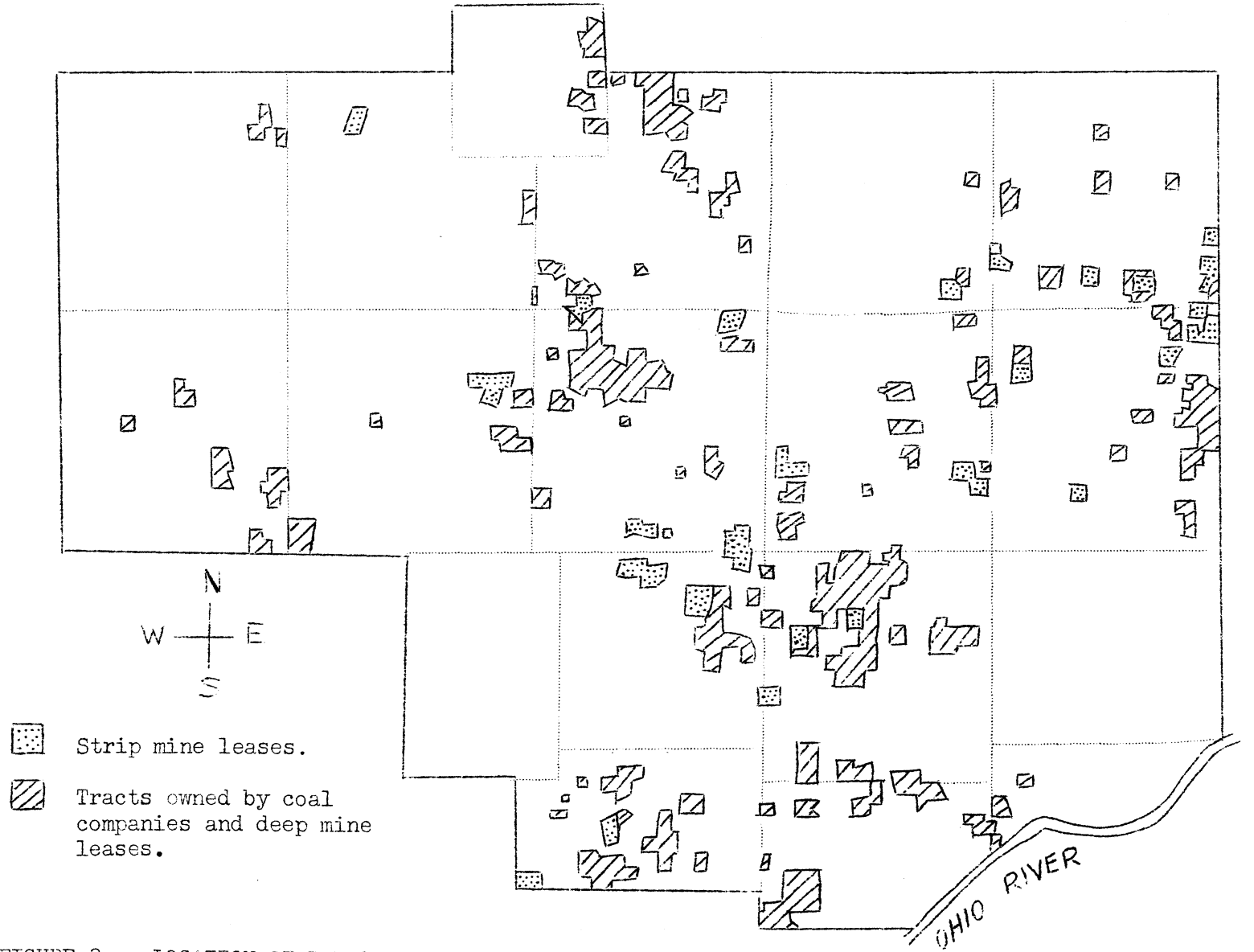


FIGURE 3.- LOCATION OF LANDS LEASED AND OWNED FOR COAL MINING PURPOSES, COLUMBIANA COUNTY, 1918-1940.
Source: Public Records.

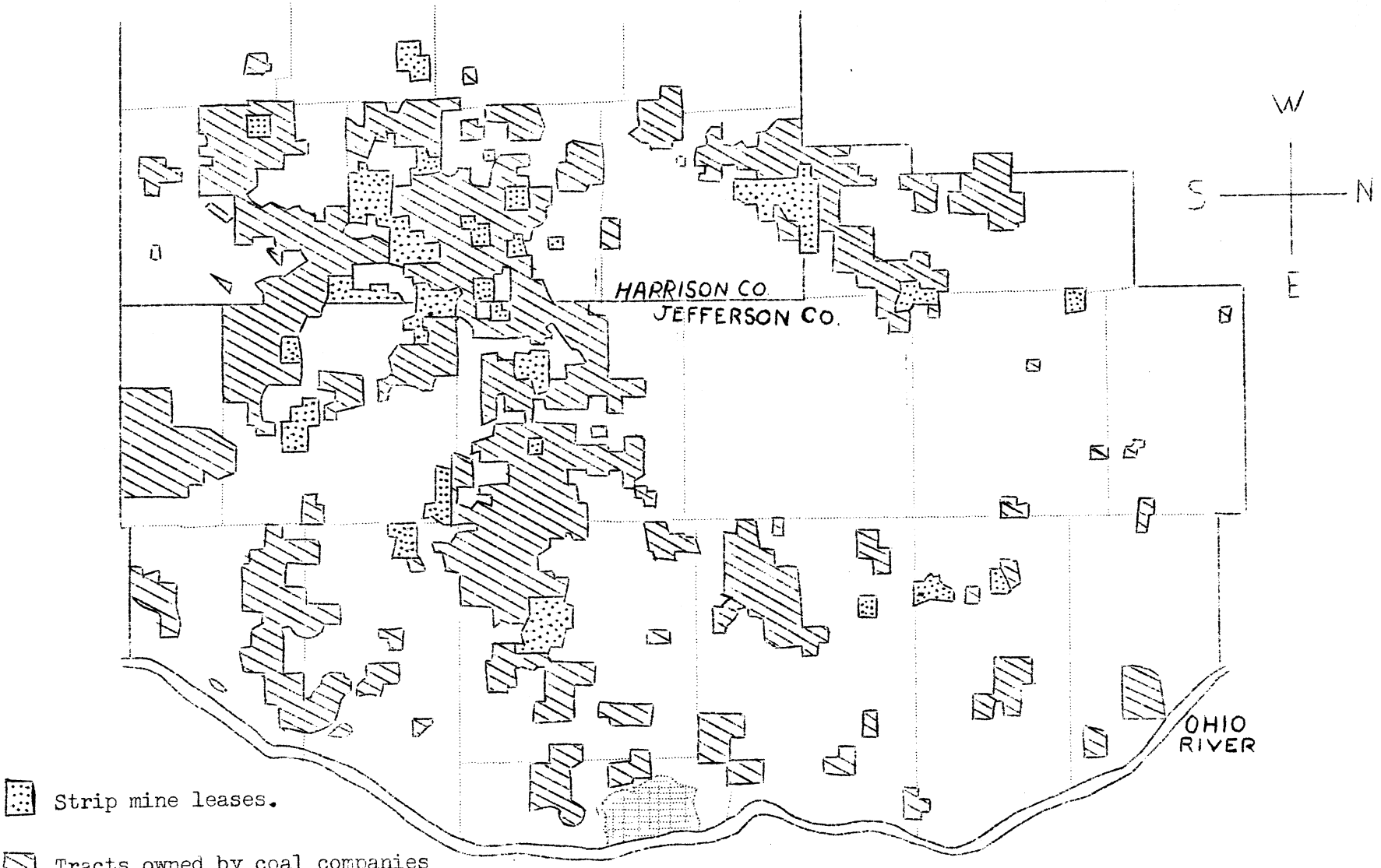
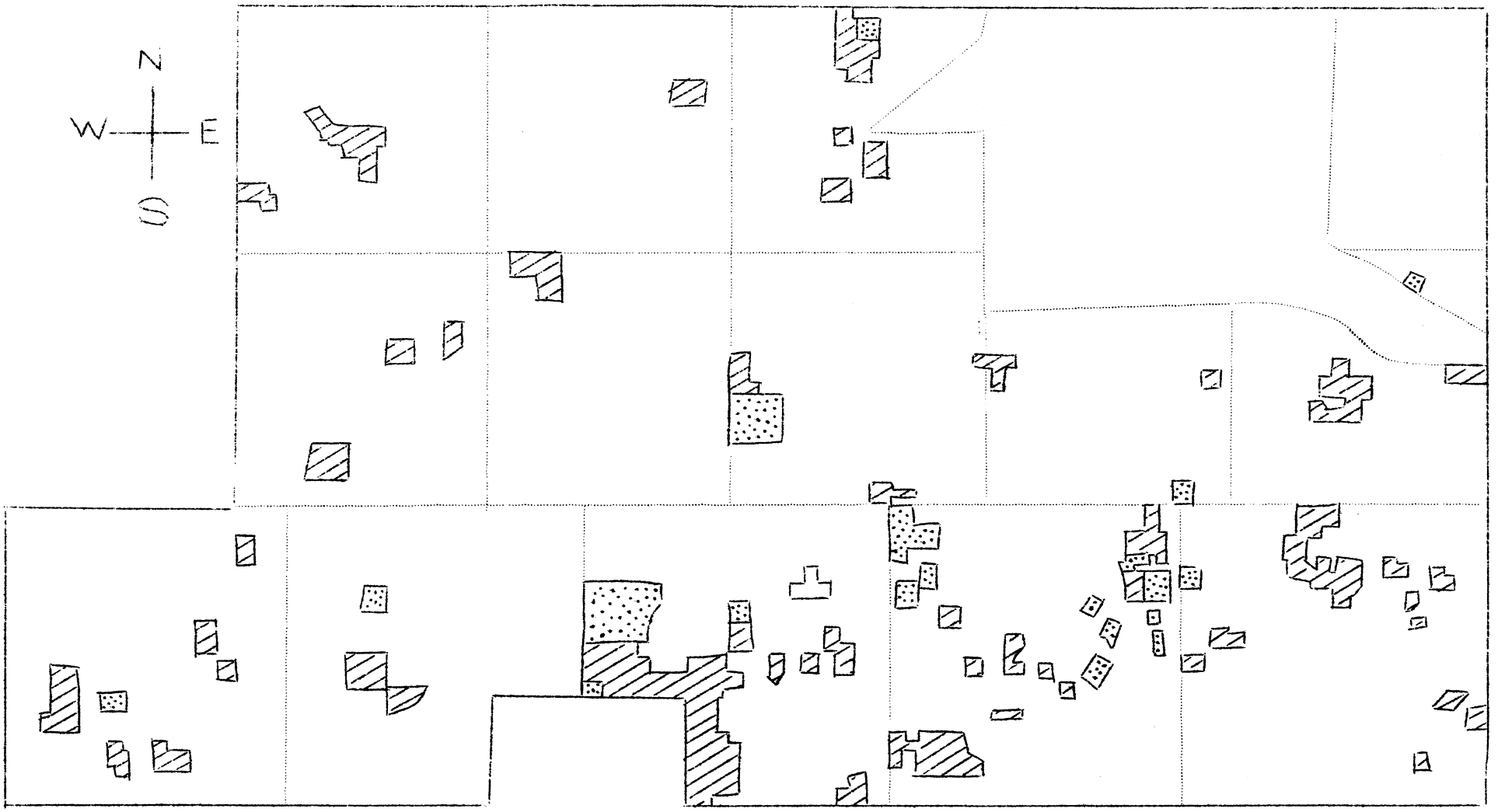


FIGURE 4.- LOCATION OF LANDS LEASED AND OWNED FOR COAL MINING PURPOSES, JEFFERSON AND EASTERN PART OF HARRISON COUNTY, 1920-1940.

Source: Public Records.



Strip mine leases.

Owned by coal companies and deep mine leases.

FIGURE 5.- LOCATION OF LANDS LEASED AND OWNED FOR COAL MINING PURPOSES, MAHONING COUNTY, 1920-1940.
Source: Public Records.

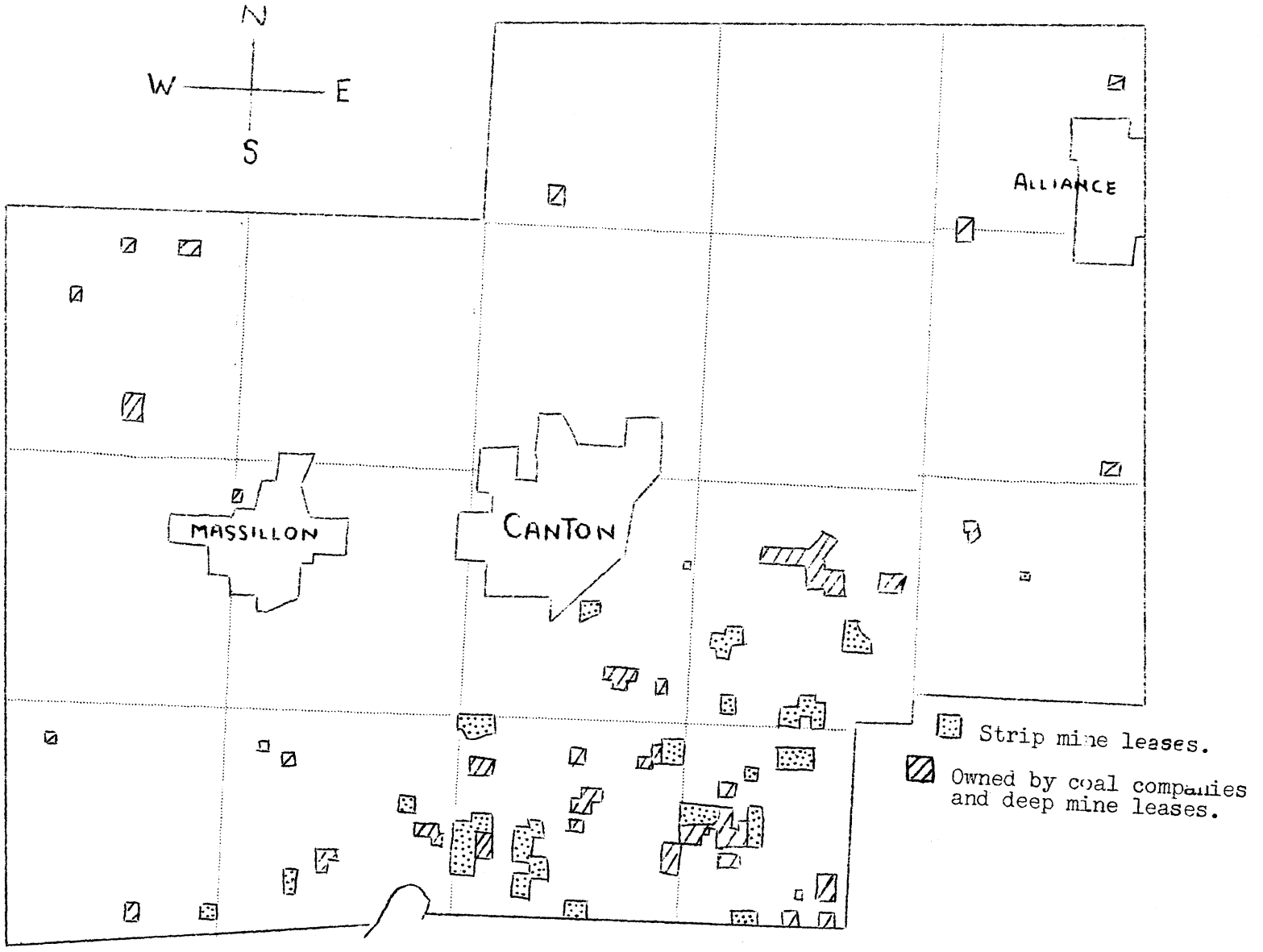


FIGURE 6.- LOCATION OF LANDS LEASED AND OWNED FOR COAL MINING PURPOSES, STARK COUNTY, 1923-1940.

Source: Public Records.

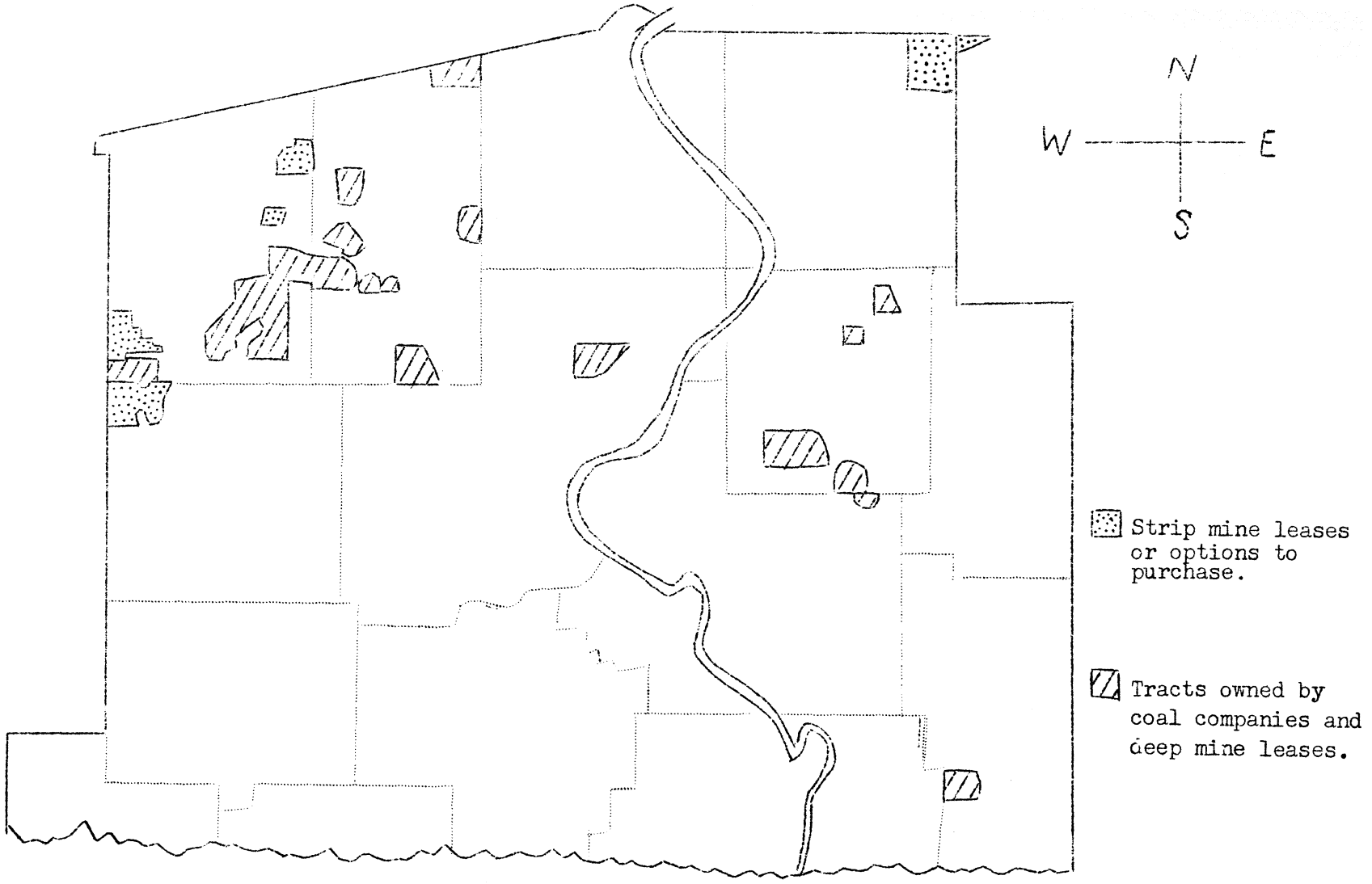


FIGURE 7.- LOCATION OF LANDS LEASED AND OWNED FOR COAL MINING PURPOSES, TUSCARAWAS COUNTY, 1930-1940.

Source: Public Records.

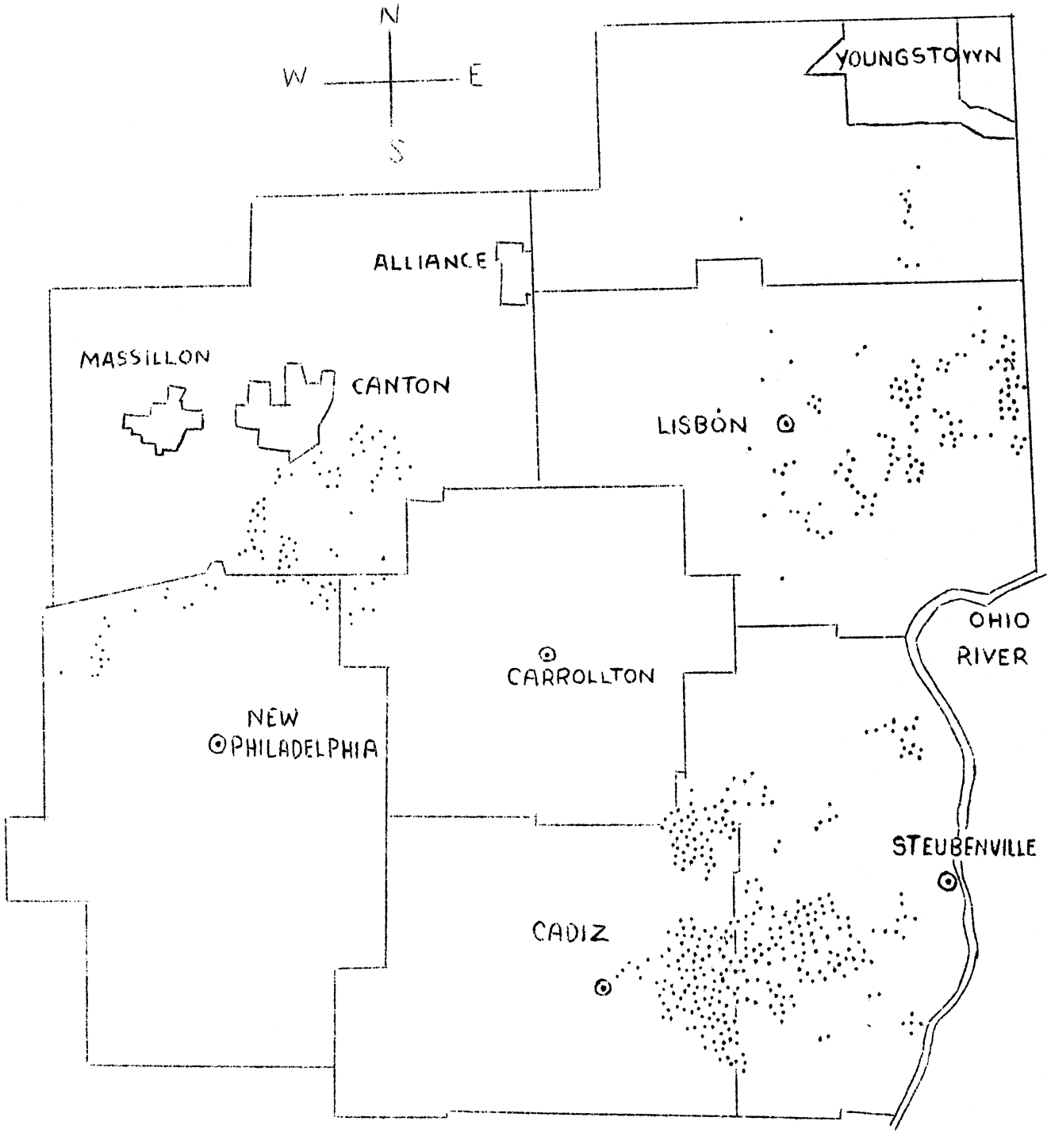


FIGURE 8.- LOCATION OF STRIP-MINE SPOIL BANKS, SEVEN EASTERN OHIO COUNTIES, 1940.

Note: Observe that strip mining in eastern Ohio can be separated roughly into three fields. (1) The Harrison-Jefferson field is the most extensive contiguous area and contains the greatest concentration of strip-mine operations. (2) The Tuscarawas - Stark and (3) the Columbiana - Mahoning areas represent lesser developments scattered over an extensive territory.

The Effect of Strip Mining on the Tax Base

Because strip-mined land is often reduced to virtual waste, it is reasonable to suppose that when the coal is once removed the land will either become tax delinquent or will be practically negligible in the support of government. Such circumstances have not developed seriously so far. It is true that some mined-out lands have been sold for taxes and others are tax delinquent; but in general, tax delinquency is no more serious in those townships where much strip mining has been done than in surrounding townships where little or none exists. The following reasons are given in explanation: (1) Only a part of the average tract is actually torn up. The remaining part of the land surface may possess value for various uses. (2) In a great many cases a part of the same coal vein or a deeper one is being held and will be mined later by other methods. Under these circumstances the taxes are usually paid on the land. Also, oil and gas leases on some lands, or the prospects for such developments, encourage the payment of taxes. (3) So long as mining operations are uncompleted in a neighborhood, company-owned lands usually have the taxes paid up as a matter of policy.

To use a specific illustration, 17 percent of the rural land in Jefferson County has been tax delinquent four or more years (1935 to 1938 inclusive). In Wayne township, which is the center of strip mining, only 11 percent has remained delinquent during the same period; and only one-half the 11 percent is strip-mined land, the remainder being land which is neither owned nor leased for strip mining nor has any spoil banks from previous operations.

Likewise, three reasons explain why the tax base in strip-mine areas has not declined as fast as may have been anticipated:

(1) Tax officials so far (in some counties) have vigorously opposed reduction in the tax valuation of strip-mined lands.

(2) Some of the wealth produced by strip mining is converted into real estate improvements in the same taxing district or even on the same tract of land. Some outside wealth is also converted into buildings on strip-mined tracts.

(3) In no taxing district has the land been completely mined out so that the full impact of the eventual loss in tax valuations has not been felt to date.

Although tax delinquency of coal lands is not generally serious, it is desirable to point out how much does exist; this is done in Table 3, page 15, which shows the extent of tax delinquency on coal lands in selected townships of Harrison, Jefferson and Columbiana counties.

Table 3.- REAL ESTATE TAX DELINQUENCY ON COAL LANDS IN SAMPLE TOWNSHIPS, HARRISON, JEFFERSON, AND COLUMBIANA COUNTIES, SELECTED YEARS.

	German, Green, Shortcreek Townships; Harrison County				Smithfield, Wayne, Crosscreek Townships; Jefferson County				Center, Washington, Franklin, Yellow Creek Townships; Columbiana County 3/			
Year	Surface 1/ (Acres)	(Delinquency)	Minerals 2/ (Acres)	(Delinquency)	Surface 1/ (Acres)	(Delinquency)	Minerals 2/ (Acres)	(Delinquency)	Surface 1/ (Acres)	(Delinquency)	Minerals 2/ (Acres)	(Delinquency)
1938	457	$2,421	—	—	2,063	$1,130	29	$56	1,035	$10,190	8,302	$23,421
1936	486	2,344	634	$1,482	2,389	2,195	225	414				
1929	4,893	4,764	560	1,000	1,127	1,210	87	189				
1924	2,180	2,689	4,146	881	419	227	—	—				

1/ Where the land is owned in fee simple.

2/ Separately-owned mineral rights.

3/ Includes land and buildings owned by clay companies who also mine coal.

Note: With the revival of business since 1935, the tax delinquency on coal lands has been reduced to an almost negligible quantity in Harrison County; in Jefferson - the reduction is slight; in Columbiana, important developments in strip mining are so recent that no significant comparisons can be made. The total amount of delinquency given in Table 3 includes delinquency, penalties and interest.

The Tax Valuation of Coal Lands

The tax valuation of specific tracts of coal lands now held for mining purposes by companies and individuals was traced from 1918 to 1937; the purpose being to obtain some measurement of the effect of depletion of coal reserves on the tax base, (Table 4). The areas so selected were in those townships where strip mining is concentrated.

Table 4.- TREND IN THE TAX VALUATION OF SELECTED COAL LAND 1/ COMPARED WITH THE TREND OF ALL RURAL REAL ESTATE IN HARRISON AND JEFFERSON COUNTIES

Area	Average valuation in dollars per acre - land and buildings			
	1937	1931	1925	1918
Harrison County:				
All rural real estate	32.44	38.21	56.20	45.04
Coal lands 2/	39.13	44.20	97.77	83.26
Jefferson County:				
All rural real estate	65.29	81.69	120.53	75.43
Coal lands 3/	32.25	32.98	58.82	83.98

1/ Located in six townships where strip mining is concentrated.
2/ A total of 10,782 acres owned for coal mining purposes in German, Green and Shortcreek townships.
3/ A total of 9,240 acres owned for coal mining purposes in Cross Creek, Smithfield and Wayne townships.

It is the usual practice in mining areas to increase the tax valuation of lands once coal mining operations establish the fact that valuable coal is present. This results in a temporary increase in the tax base which is subsequently reduced as the coal is mined out over a period of time.

The average tax valuation of specific tracts of coal lands in Harrison County declined from $83.26 per acre in 1918 to $39.13 in 1937, a 53 percent loss as compared with a 28 percent loss on all rural real estate in the county. A similar comparison in Jefferson County indicated a loss of 62 percent in the valuation of the coal lands as compared with a 13 percent loss on all rural real estate in the county. In the same period the tax valuation of all rural real estate in Ohio declined 15 percent, a trend influenced by economic conditions in general.

The above comparisons and the figures in Table 4 indicate that the tax valuations of coal lands have been reduced more rapidly than have valuations of other real estate. The difference, it may be inferred, is due to the depletion of the coal which in the course of another quarter century will probably be nearing exhaustion in the areas where strip mining is now concentrated.

PRESENT UTILIZATION OF STRIP-MINED TRACTS OF LAND

After a tract of land has been strip mined its use may be modified in several ways. To illustrate:

(1) Occasionally so little land in a tract is actually torn up that the use of the remaining land is unchanged. Under such circumstances a full-time farm remains a full-time farm.

(2) In some cases enough cropland or pasture either will be destroyed or so isolated from the farm buildings that the tract is reduced to the status of a part-time farm.

(3) Frequently, very little usable land is left unmined and the only use that is made of the tract is occupancy of the buildings by persons employed elsewhere.

(4) In still other cases the land is left in such condition that it is completely abandoned.

(5) In a few cases lands have been reforested.

This general pattern is sometimes modified by the fact that a strip-mined tract is occasionally consolidated with an adjoining farm. In still other instances, where the unmined portions are conveniently located they may be broken up into small tracts and used as building sites or part-time farms. In a few cases where fishing and other recreational facilities may be developed, strip-mined lands are being acquired by sportsmen's clubs.

Seventy-six holdings of strip-mined lands were studied in an effort to learn something of the effect of strip mining upon land utilization in those cases where human occupancy continues. The holdings studied ranged in size from about one to 1,000 acres. The circumstances of land use and occupation of the various residents make up a rough cross-section of conditions which generally prevail in these strip-mined areas.

The Harrison-Jefferson strip-mine area can be considered on the whole as a single contiguous region having essentially the same physical features. However, it so happened that most of the larger tracts of land studied were located in Harrison County which explains why in Table 5, the average holding in Harrison was 175 acres as compared with only 81 acres in Jefferson County. Part-time farming is important in both counties; however, most employment opportunities, excluding mining, are to be found in the towns along the Ohio River. Thus, it may be inferred that a greater demand for small and medium size tracts would probably exist nearer these towns and in Jefferson county rather than in Harrison county.

Table 5.- LAND UTILIZATION AND OTHER FACTORS RELATED TO THE OCCUPANCY OF SEVENTY-SIX TRACTS OF LAND AFFECTED BY STRIP MINING IN COLUMBIANA, HARRISON AND JEFFERSON COUNTIES, 1940

		Columbiana	Harrison	Jefferson	Total
Number of tracts		21	24	31	76
Average size of tracts	(acres)	78	175	81	110
Total area	(acres)	1,634	4,190	2,510	8,334
Area not strip mined	(acres)	1,372	3,292	1,978	6,642
Area strip mined	(acres)	262	898	532	1,692
Percentage of area strip mined		16	21	21	20
Use of Unmined area:					
Cropland	(acres)	798	692	469	1,959
Open land pasture	(acres)	486	2,164	941	3,591
Brush and timber	(acres)	55	198	53	306
Waste	(acres)	33	238	515	786
Percentage of unmined area in:					
Cropland		58	21	24	29
Open land pasture		35	66	48	54
Brush and timber		4	6	3	5
Waste		3	7	25	12
Percentage of mined area:					
Used for pasture		17	45	15	31
Waste land		83	55	85	69
Average acres in individual tracts in particular uses:					
Cropland		38	30	15	26
Pasture (unmined)		24	90	30	47
Pasture (strip mined)		2	17	2	7
Woods and brush		2	8	2	4
Waste land (unmined)		2	10	17	11
Waste land (strip mined)		10	20	15	15

The average amount of cropland per strip-mined tract was 30 acres in Harrison as compared with 15 acres in Jefferson; a difference due mainly to a few relatively large farms in Harrison. The percentage of unmined area used for crops was 21 percent in Harrison and 24 percent in Jefferson.

Although Columbiana has considerable part-time farming within the county it is not predominately on strip-mined holdings. This is probably due to the fact that in most instances, strip mining in Columbiana county usually has involved only a few acres on individual farms. Likewise, the amount of cropland still available on the average strip-mined farm is relatively high, 38 acres, or 58 percent of the total unmined area of the average holding. Compared with Harrison and Jefferson counties, Columbiana has less rough and broken lands with much land being only slightly rolling and quite suitable for crop production.

In one county, Columbiana, considerable information on the quality of land involved in strip-mine operations has been recently assembled. Land in this county has been classified into three distinct groups by the Land Use Planning Committee:

(1) Land which is suited to agriculture and having no serious erosion problems.

(2) Land which is suited to agriculture although having serious erosion problems.

(3) Land not suited to agriculture.

On the basis of soil, slope and erosion, Columbiana County has more land suited to agriculture than Harrison or Jefferson while it has proportionately less of such land than Mahoning and Stark counties. No one can be certain what quality lands may be utilized for agriculture in the future. But in view of present trends in use and abandonment, it is estimated that at least 75 percent of all strip mining in eastern Ohio will be confined to areas where the land is poorly adapted to future agricultural use.

Table 6.- LOCATION OF PRESENT SPOIL-BANK AREAS AND AREAS LEASED FOR FUTURE STRIP-MINE OPERATIONS, COLUMBIANA COUNTY, 1940

	Strip mining to date; spoil-bank areas at present	Recorded leases; future banks
	Percent	Percent
Areas suitable for agriculture having no serious erosion	15	24
Areas suitable for agriculture but having serious erosion	49	25
Areas not suitable for agriculture	36	51
Total	100	100

Source: Columbiana County Land Use Planning Committee and Public Records.

Table 7.- FORMER USE OF STRIP-MINED LAND, AREA SUITED AND UNSUITED TO AGRICULTURE, COLUMBIANA COUNTY, 1940

Form Land Use	Strip-Mined Lands In Agricultural Area	Strip-Mined Lands In Non-agricultural Area
	Percent	Percent
Cropland	62	45
Pasture	32	22
Woods and waste	6	33
Total	100	100

Source: Columbiana County Land Use Planning Committee.

Table 8.- COMPARISON OF LAND USE ON 76 STRIP-MINED TRACTS WITH THE AVERAGE LAND USE IN 1929 and 1934, COLUMBIANA, HARRISON, AND JEFFERSON COUNTIES, 1940

	County		
	Columbiana (acres)	Harrison (acres)	Jefferson (acres)
Average size farm for county, 1929	79	119	111
Average size farm for county, 1934	69	121	94
Average size strip-mined tract, 1940	78	175	81
Cropland, average farm, 1929	40	36	37
Cropland, average farm, 1934	36	32	29
Cropland, strip-mined tracts, 1940	38	30	15
Open pasture, average farm, 1929	16	64	43
Open pasture, average farm, 1934	20	66	38
Open pasture, strip-mined tracts, 1940	24	90	30
Woods and other land, average farm, 1929	23	20	20
Woods and other land, average farm, 1934	23	21	27
Woods and other land, strip-mined tracts, 1940	16	55	35

Source: U. S. Farm Census; 1929, 1934; Survey of 76 Strip-Mined Tracts, 1940.

The comparisons in Table 8 indicate that the average farm in Columbiana County which has been strip mined still has as much cropland and pasture as the average farm in that county. However, in Harrison and Jefferson counties, the strip-mined tracts appear to have a deficiency in cropland and in Jefferson County a deficiency in pasture as well. In Harrison and Jefferson in particular, strip mining contributes to a need for enlarging the remaining farm unit or for obtaining outside employment as an alternative source of income.

Data presented in Table 9, page 21, shows in summary fashion the results determined from the interviews and observations made on 76 strip-mined farms in the Columbiana, Harrison, and Jefferson area in eastern Ohio.

Relation of Strip Mining to People

Strip mining seldom destroys a tract so completely as to make human occupancy impossible; usually, more or less desirable building sites are left, or as was observed in Knox township, Jefferson County, dwellings may actually be constructed among the unleveled spoil banks. This would indicate that some people regard the older spoil banks as suitable home sites. It would thus be reasonable to expect these people to be rather complacent toward strip mining in general. As a matter of fact some farmers have

Table 9.- SEVENTY-SIX TRACTS OF STRIP-MINED LAND GROUPED ACCORDING TO THE AMOUNT OF LAND IN CROPS

	Individual tracts classified according to amount of land in crops							
	No land in crops except home garden	Some, but less than 5 acres	5-9 acres	10-19 acres	20-29 acres	30-49 acres	50 acres or more	Total or average
Number of tracts	10	9	6	12	10	11	18	76
Average total acres per tract	33	22	82	67	137	110	222	110
Estimated percentage of family income from agriculture 1/	12	23	35	64	70	84	89	60
Condition of buildings:								
House: good - no.	3	1	1	4	5	4	11	29
fair - no.	1	6	3	6	4	6	5	31
poor - no.	6	2	2	2	1	1	2	16
Barn: good - no.	0	1	0	0	2	3	7	13
fair - no.	3	4	1	4	5	7	9	33
poor - no.	5	2	3	6	3	1	2	22
Other buildings:								
good - no.	0	0	1	1	1	0	0	3
fair - no.	2	1	0	3	3	7	11	27
poor - no.	7	1	5	8	6	4	6	37
Quality of land, unmined area: good - acres	0	0	0	3	5	10	24	8
fair - acres	1	3	6	20	32	44	75	33
poor - acres	27	13	57	31	63	40	81	47
Slope of land, unmined area: level - acres	0	0	0	6	2	5	7	4
gently rolling-acres	7	4	4	19	14	27	48	23
rolling-acres	13	8	31	12	45	29	74	34
steep - acres	8	4	28	17	39	33	51	27
Area in spoil banks - acres	5	6	19	13	37	16	42	22

1/ Exclusive of the value of housing.

demonstrated a similar complacency despite the fact that land often needed for crops is destroyed by the mining process. This attitude was explained by two farmers who said that there was already so much idle land in their neighborhood that it was of little consequence if a few more acres were destroyed. Other farmers deplore the destruction and favor restrictions on strip mining.

As has been previously indicated a source of outside income often becomes necessary when tracts are strip mined to any great extent. A considerable proportion of the householders living on the strip-mined tracts indicated that a share of their living was obtained from outside sources. This situation is the result of various employment opportunities in the vicinity. Drift and shaft mines are scattered all through the strip-mine region giving employment to truck drivers, miners, etc. Urban industries along the Ohio River draw some of their labor from this region since the local demand for labor by farmers is so small that surplus labor must go to near-by urban areas to find work. Families usually continue to live in the strip-mining areas, however, because transportation and housing are relatively cheap. It is important to recognize that strip mining is only one of several factors contributing to the increase in part-time farming and the pursuit of non-farm occupations by residents of strip-mined areas.

As classified in Table 10, 41 percent of the heads of households was employed in agriculture as compared with 26 percent employed as miners, and 16 percent employed in industry. The number dependent upon work relief was only 6 percent.

Table 10.- PRINCIPAL OCCUPATION OF HEADS OF HOUSEHOLDS LIVING ON 76 STRIP-MINED TRACTS IN COLUMBIANA, HARRISON AND JEFFERSON COUNTIES, 1940

Principal occupation	County			Total, all three counties	
	Columbiana	Harrison	Jefferson	(Number)	(Percent)
Farm operator	13	10	9	32	41
Miner	3	8	9	20	26
Industrial worker	2	4	6	13	17
Day laborer	2	3	-	5	6
Truck and bus driver	-	2	1	3	4
Work relief	-	1	4	5	6
Total	20	29	29	78 1/	100

1/ Seventy-eight households occupied the 76 tracts.

An effect of strip mining is to create a period of instability in community life because persons who lease or sell their land for strip-mining purposes often move to new locations, being replaced in some cases by persons who have more interest in mining and industry than in agriculture. Some measure of this is indicated by the fact that 59 percent of the occupants of strip-mined lands were obtaining a substantial share of their income from non-farm sources. This situation, it has been pointed out, is not entirely the result of strip mining, because much of the land involved is not suitable for commercial agriculture.

Table 11.- HEADS OF HOUSEHOLDS, CLASSIFIED ACCORDING TO LENGTH OF RESIDENCE IN PRESENT LOCATION, 53 STRIP-MINED TRACTS, HARRISON AND JEFFERSON COUNTIES, 1940 1/

Length of Residence (Years)	Harrison number	Jefferson number	Total number	Total percent
Less than 5	10	11	21	40
5 - 9	4	3	7	13
10 - 19	4	7	11	21
20 or more	6	8	14	26
Total	24	29	53	100

1/ Data not obtained for Columbiana County.

It was found in Harrison and Jefferson Counties that of 53 families living on tracts of land which had been strip mined, 21 families (40 percent) had lived in their present location less than 5 years as compared with 14 families (26 percent) which had lived in their present location 20 years or longer. A number of the new residents (14 percent) were foreign born. For the most part these were miners attempting to supplement uncertain income by part-time farming.

Some Physical Limitations on the Use of Spoil Banks

The future utilization of this land is a controversial issue because up to the present time, no use has been successful enough to definitely point the way. In fact so many conditions exist that probably no single use will prove equally satisfactory for the following reasons:

(1) The depth of strip mining.- When only a few feet of earth are turned upside down the ground may not be left in an extremely rough condition. The vertical distance from the bottom of hollows to ridge tops may be only 3 to 6 feet and this difference is lessened by the forces of erosion and soil settling. Vegetation can gain a foothold under these circumstances with relative rapidity and future use for forestry and even pasture holds some promise. As the depth of mining increases the practical possibility for these uses diminishes.

(2) The character of the subsoil. - The practical use which can be made of spoil banks also depends on the character of the geological formations overlying the coal. Because these formations are fairly uniform, some indication of the possible future use of these lands can be obtained by determining which vein of coal is strip mined in an area. It must be understood that in the disposal of the overburden all soil stratifications are broken up and indiscriminately mixed. On the other hand the stratum immediately over the coal tends to be on the surface and what was once surface material tends to be on the bottom of the heap.

Table 12.- COMPOSITION OF THE OVERBURDEN ABOVE COAL MEASURES WHICH HAVE BEEN STRIP MINED IN SIX EASTERN OHIO COUNTIES

Coal Measure (Seam number)	Average 1/ distance to the coal seam above (feet)	Location of strip mining (County)	Composition of the first 50 to 75 feet of material above the coal seam
No. 9	(highest seam)	Harrison 2/	Immediate cover of 20 feet or less of sandstone and shale with some limestone and calcareous shale above.
No. 8	80	Harrison Jefferson	Immediate cover of from 5 to 10 feet of sandstone and shale, then 45 feet of limestone and marly shales and another 20 feet of sandstone and shale.
No. 7	400	Columbiana	Cover of about 25 feet of sandstone and shale, then very thin deposits of limestone and about 25 feet additional of sandstone and shale.
No. 6	92	Columbiana Stark Tuscarawas	Immediate cover of a few feet of marine shale, then 65 feet of sandstone and shales with patches of thin coal and clay.
No. 5	24	Columbiana Stark Mahoning Tuscarawas	The No. 5 coal is separated from the No. 6 vein by 4 to 5 feet of unsteady limestone and about 20 feet of shales, clays, and thin coals. They are sometimes mined together in one operation.

1/ Average as determined from the Geological Survey of Ohio.
2/ Only a few acres strip mined on the ridge tops in southeastern part of the county.

As a consequence, spoil banks with a top layer of slate and non-calcareous shale offer a poor opportunity for reclamation through the development of a vegetative cover, for too little good parent material is sufficiently near the surface to build a productive topsoil. On the other hand spoil banks with a top layer of mixed limestone, calcareous marl and clay contain the raw materials which encourage the soil-building process.

Spoil banks even in the same area vary considerably in the character of top material. But in general, the sharp division exists between those areas where the No. 8 (Pittsburg Coal) coal is mined and all other strip-mine areas. 1/ At this point it need be explained that the coal measures in Ohio are designated numerically, the deepest vein being number one. In the area studied the deepest vein of coal which is strip mined to any extent is No. 5; but on the northern margin of the strip-mine area, Mahoning County, this vein is sometimes erroneously designated as No. 3a. Moving to the south and southwest, in Stark county, veins 5 and 6 are being strip-mined; in Columbiana Nos. 5, 6, 7; in Tuscarawas No. 5 and 6; in Harrison and Jefferson, No. 8. It may be asked how can all these different veins of coal be near enough to the surface to be strip mined when they exist in a continuous vertical series? The reason is that the earth's strata in this region are tilted to the south of east with an average declination of 35 feet per mile. But this average dip is not uniform being modified by anticlines which locally may even reverse the direction of dip. Due to this circumstance and also to variable thickness of most coal veins it is necessary to verify the position and thickness of the vein before stripping by means of test drilling which has become a standard practice. Formerly strip-mine operations were frequently failures financially because strippable coal was not present as anticipated.

It has been mentioned that the presence of calcareous material such as limestone or marl is favorable to the development of a vegetative cover. The outstanding example of this effect is on the spoil banks where the No. 8 coal has been strip mined. Within the first 50 feet over the No. 8 coal there exists from 30 to 40 feet of limestone and marly shale. Such spoil banks almost invariably have a pH of 7 or more which indicates the presence of sufficient lime to grow leguminous plants such as clover and alfalfa. As a matter of fact nearly all spoil banks in Harrison and Jefferson counties are rapidly covered with sweet clover wherever this legume is sown and often eventually by natural seeding. In the course of this study alfalfa was found growing luxuriantly in three instances, twice in small patches and once in an area of one-half acre which was being harvested for hay.

In contrast, the No. 7 coal is overlain with 25 feet of shale or sandstone followed by 2 feet of limestone, 5 feet of clay followed by 20 feet of shale and some thin veins of coal.

The No. 6 coal is overlain by a 4 foot layer of marine shale which in some instances contains a fair supply of calcium. On the other hand little sweet clover is found growing on the spoil banks in the Sandy Creek Valley of northern Tuscarawas and southern Stark counties where the No. 6 coal is being strip mined, which indicates that as a general rule this same shale cannot be depended on to supply the needed calcium.

1/ There is an exception to this rule: Some No. 9 coal has been strip mined in Belmont County and in areas of southern Harrison where two leases contemplate strip mining of the No. 9 coal. The nature of the overburden of No. 9 is intermediate between that of the No. 8 and Nos. 7, 6, and 5 coals.

The No. 5 coal which is strip mined to some extent in Columbiana County lies only 24 feet beneath the No. 6 vein. On some hill sides both veins are mined concurrently in the same operation. Just above the No. 5 vein an unsteady stratum of limestone up to 4 feet in thickness may add a supply of calcium to the surface of spoil banks in some instances. 1/

As a general conclusion only in case of the No. 8 coal is there enough calcium in usable form present on the spoil banks to be an important factor in the reclamation of such land. In respect to all other veins enough calcium is occasionally present to encourage the development of a cover of sweet clover but as a general rule the relatively barren appearance of the spoil banks even after a period of 10 to 20 years after the mining operations are completed supports the opinion that the building of a topsoil will be a matter of centuries rather than years or decades.

RECLAMATION AND USES OF LAND IN SPOIL BANKS

Should Spoil Banks be Leveled?

Whether or not spoil banks should be leveled to the original topography is a controversial issue at present. Casual consideration of the question may lead observers to conclude that leveling would not only reclaim the land and fit it for profitable future use, but also remove the unsightly and depressing appearance of such areas. On the other hand, individuals engaged in strip mining or owning such land point out the prohibitive cost of leveling. Other factors to consider are the questionable present value of such land though leveled, and the serious erosion problem which arises when a great depth of loose earth is leveled off to a constant slope.

Some leveling has been done and a few recorded leases provide for leveling at the option of the landowners. Unfortunately, such evidence is so scattered that no conclusions may be drawn from it alone. It has, however, been taken into account with all other available evidence which has been assembled in this report to show as far as possible the existing situation in respect to leveling.

The cost of leveling was found to vary greatly with the location. Some leases in Mahoning and Stark counties contained a clause, optional with the landowner, providing for a deduction in the royalty paid for coal ranging from 4 cents up to 10 cents per ton as a charge for leveling. This would amount to from 150 dollars to 600 dollars or more per acre depending upon

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1/ One strip-mined tract in Fairfield Township, northeastern Columbiana County, has a luxuriant cover of sweet clover.

the yield of coal. In one case the mining company agreed to level for a flat charge of 50 dollars per acre to be paid by the landowner. It is assumed that in this particular case the mining company was sharing part of the expense of leveling. In another instance a farmer had himself leveled four acres in northeastern Columbiana County at a cost of 180 dollars per acre. It should be emphasized that these cases apply only to Columbiana, Stark and Mahoning counties. Miners and landowners alike stress the practical impossibility of leveling most of the spoil banks in Harrison and Jefferson counties where the No. 8 vein is covered with a thick stratum of limestone. This excessive amount of large rocks makes the expense of leveling much greater. In a few cases leveling can be done, however, and one farmer has partially leveled a bank using a team and ordinary farm equipment. It was his belief that all the banks on his farm could be sufficiently leveled by this means. His was not a typical situation because the banks were shallow as the result of working off the top cap of a hill. A few other similar situations exist in Harrison and Jefferson counties but the vast majority of spoil banks in this area are filled with stone.

The opinion is often expressed that mining companies should be required to level all land which they strip mine. It is assumed that this obligation could be legislated into being. It may be pointed out that regardless of such laws, in the long run the cost of leveling will finally fall on the landowner, either being deducted through lower royalties, or lower purchase prices paid for coal-bearing lands. In case the land is already owned or leased by the mining company the expense of leveling could not be shifted or escaped. If such expense were prohibitive it would probably prevent a continuation of mining operations.

Strip-mine leases which have been recorded indicate a considerable range in the amount of royalty which is paid to the landowner. Aside from the variation due to bargaining it is obvious that several factors might affect the amount of royalty as for instance, the thickness of the overburden, the nature of the overburden (whether stone, shale, clay, etc.) the thickness of the vein of coal, its quality, its distance from market, and the probable size of the area which can be mined without costly movement of equipment. Royalty rates in individual recorded leases range from 5 cents to 35 cents per ton of coal mined with the majority specifying between 10 and 25 cents. As compared with these royalties, the deductions for leveling specified in a few leases range from 4 cents to 10 cents per ton. It is obvious that in some cases return from royalties might be entirely wiped out by the expenses of leveling.

In Table 13, page 28, royalty rates as designated in leases in the various counties are given for both deep and strip mines. In most cases strip-mine royalties averaged higher than those for deep mines. This indicates some probable cost advantage to the strip method of mining.

To sum up, the chief practical objections to complete leveling are as follows:

(1) The excessive cost.
(2) The serious erosion problem.
(3) The absence of topsoil results in low productivity and low value land.

The question may be asked, is it sound to spend hundreds of dollars per acre to level off spoil banks which when level cannot produce as much as the unmined land in the same neighborhood which can be purchased for 10 to 30 dollars per acre?

It should also be remembered that as a rule strip-mined tracts usually have less than 50 percent of their surface in actual spoil banks and the average for all tracts is nearer 25 to 33 percent. 1/ It would seem more practical to use some of the wealth made available by strip mining to improve the remaining unmined portion of each tract than to spend it to level the actual spoil banks.

Table 13.- ROYALTY RATES PER TON OF COAL, STRIP AND DEEP MINE LEASES RECORDED IN VARIOUS COUNTIES, EASTERN OHIO

County	Cents per Ton					
	Strip Mines			Drift and Shaft Mines		
	Lowest Rate	Highest	Average*	Lowest Rate	Highest	Average*
Columbiana	8	25	15	2½	30	10
Harrison	10	25	16	4	25	7
Jefferson	5	15	10	3	30	14
Mahoning	10	35	18	5	45	15
Stark	6	25	15	6	32	17
Tuscarawas	10	25	18	6	35	12

*Note: Average rate weighted by the acreage leased.

Partial leveling of spoil banks by merely reducing the slopes to 20 to 30 percent might be less expensive and at the same time economically feasible. However, no actual demonstrations exist to indicate the cost of a minimum amount of leveling required to adapt spoil banks to some alternative use such as pasture, forestry or recreation. Experimental work is needed to determine the cost and success of partial leveling.

Three main incentives have caused landowners to level strip-mined lands in the past. First, the belief that by doing so such land could be reclaimed for profitable agricultural use; and second, to remove the unsightly spoil banks in the vicinity of buildings, based partly on aesthetic motives and partly on the belief that the value of the farm as a whole would be increased by at least the cost of leveling. Third, it was sometimes desired to fit lands for use as residential sites or for other urban uses, a situation which sometimes prevails on the edge of population centers such as East Canton in Stark County.

Areas in spoil banks have in the past been used (when utilized at all) for three main purposes with only minor exceptions. So far the proposed future uses are still confined to these three main uses: pasture, forestry,

1/ Spoil banks and pits cover more area than the land actually mined because the earth from the first cut is piled on unmined land.

and a combination of wild life and recreation. 1/ It should be pointed out that the results already achieved with these three uses are not yet entirely conclusive. On the other hand these results in combination with the experience and judgement of specialists in agronomy, forestry and wild life do seem to help appraise the available opportunities and aid in weighing the relative merits of each.

Pasture

It was found that in Columbiana, Harrison, and Jefferson counties, an average of 31 percent of the spoil banks on the farms visited were being pastured. This did not necessarily mean that much forage existed even though livestock were permitted to range over the mined areas. In Columbiana County in particular, the scanty growth of forage on the spoil banks limits the carrying capacity to such a low number of animals that their use as pasture is of little importance. In Harrison and Jefferson counties a few farmers claimed that spoil banks when seeded to sweet clover had greater carrying capacity than nearby badly depleted unmined lands. Evidence that this would remain the case over a long period of years was lacking, however.

Professor D. R. Dodd, Pasture Specialist, The Agricultural Extension Service, Ohio State University, has observed the practice of pasturing strip-mined lands for a number of years and his conclusions based on such observation can be stated as follows:

(1) A satisfactory stand of sweet clover is not maintained under the prevailing pasture practices.
(2) The carrying capacity fluctuates widely from year to year and the pasturing season is abnormally short.
(3) The spoil banks are usually so rough that pasture improvement and maintainance by means of fertilizer, mowing, etc., are impractical and as a consequence pasturing is an exploitative process which can only exhaust the land rather than rebuild it.
(4) Pasturing retards the process of soil building so that spoil banks tend to become piles of rock and shale with the finer soil particles completely eroded from the surface of the steep slopes.
(5) A thin stand of bluegrass may eventually develop on the top of spoil bank ridges and in the bottom of depressions but almost never enough to make fair quality pasture. Much of the surface area of spoil banks will remain bare ground when pastured.
(6) A few losses of livestock result from falling from the high banks.

It would seem clear that the future productive capacity of strip-mined lands depends on the building of a topsoil, a process which took nature thousands of years in the case of the original soil buried by the strip-mining process. To expect spoil banks to be completely regenerated in the space of a few short years is probably an extravagant hope; but some things can be done which will speed up the process of soil building. Forestry in particular has an essential place in this reclamation process.

1/ Enough evidence exists to suggest that fruit production on a small scale is practical on spoil banks. In several instances peach trees have made a satisfactory yield and a good growth of wood. A few apple trees, not yet in bearing, showed satisfactory growth, and one small vineyard was producing well. Fruit production on a commercial scale is not possible without partial leveling of spoil banks because they are generally too rough to use power-spraying equipment.

Forestry

It must be admitted that attempts to grow a crop of merchantable timber on spoil banks immediately after the mining operations were completed has so far been unsuccessful in eastern Ohio. On the other hand, the growth of trees to date has been a first step toward fitting the ground for a more valuable crop of trees to follow.

In most cases no artificial plantings of trees have been made, but natural seeding has been very rapid in some instances while in others it has been almost entirely lacking.

An appraisal of the reforestation process on spoil banks has been made by Mr. R. R. Paton, Department of Forestry, The Ohio Agricultural Experiment Station in conjunction with this study in Harrison and Jefferson counties. Mr. Paton comments as follows:

"There is a widely accepted theory among land economists, farmers, foresters and others that the only logical solution to the rehabilitation of spoil banks is to return them to forests. This theory is premised on several factors; the rugged character of the land renders tilling permanently impossible; the disturbance of the soil structure and loss of topsoil makes any but very extensive pasturing immediately and perhaps permanently out of the question; and the distribution of the areas stripped lowers the value and utility of adjacent, unstripped land.

The apparent loss of any possible agricultural use of the soil leaves, by elimination, only forest use of the land, assuming that some use should be made of all land. The question then, is how possible is it to return these areas to forests, and what methods are necessary to achieve this result?

The oldest spoil banks in this region are 25 years old and there are several of this approximate age. Two of these were examined to determine to what extent natural seeding of tree species was taking place.

The first one from a distance gives the appearance of restocking satisfactorily for it has a stand of trees over much of the area, heavy in some spots and thin or absent in others. This stand of trees proved to be the Chinese Tree of Heaven, Ailanthus glandulosa, a species which is very difficult to eradicate once established, and which may prevent the growth of more valuable species. At present it has no commercial use, although there is some possibility that it might be used for wood pulp.

Trees of all ages of this species were found up to 12 inches in diameter at stump height and 25 to 30 feet in total height, and bearing heavy crops of seed. How the original trees came into the area is unknown, although the species is widely distributed in the cities of this region.

This species was found over the entire area on this stripping operation, with stands varying from thin or entirely absent on the west slopes to very dense (15,000 per acre) on north and east slopes.

Other species found on this area were very scarce and found almost exclusively on the lower slopes and in the bottoms. Where the ailanthus was dense no other species were found. The following species were observed:

Wild cherry. All were small up to 2 - 3 inches in diameter and very scattering, not over 20 - 30 per acre.

Elms, chiefly red elm. All small, up to 2 - 3 inches in diameter, not over 10 per acre. These were restricted to the foot of the slopes in all cases.

White ash. The same as elm.

Hawthorn. Very few and less than 1 inch in diameter.

Hard maple. Only one found and that was in the bottom of a draw. Bushy formed tree, 20 feet high, 5 inches in diameter. This tree had no ailanthus under its crown, although immediately beyond there was a heavy growth of it.

Smooth sumac. Only one or two per acre.

The slopes were sodded, on the east exposures more densely than on the west, and there was very little washing taking place. One east slope had a very definite topsoil beginning to form, perhaps one-half inch in depth. Bluegrass, sweet clover, dandelions, wild carrots, and other weeds formed a good sod here. There were no tree species here aside from ailanthus which in this case was not dense.

This area had better than average opportunity for seed from native trees. There is a semi-mature mixed hardwood stand 300-400 yards to the west with prevailing westerly winds. Wind-borne seeds (ash, elm, maple) should be available over much of the area. Bird-borne seeds too should be fairly plentiful, including cherry, dogwood, sumac, hawthorn, wild apple, and elder. It is apparently not the lack of seed as much as site conditions which are proving to be the limiting factor.

Another portion of this area had an outside bank (the first or "outside" bank in a stripped area is conspicuously more fertile than the "inside" banks) with a north exposure. At the foot, on undisturbed soil, there were some butternuts, red oak, hawthorn, cherry, and wild apples, some of them seed bearing size; but on the slope, with the exception of a very few hawthorn on the lower slopes, ailanthus was the only tree species found. A fairly good sod indicated a moderately fertile soil here.

Another area of spoil banks, also about 25 years old, was examined several miles away. Here a portion of the area had been pastured for several years and the balance not at all. The entire area had been seeded with sweet clover shortly after the stripping operations ceased.

The pastured area had practically no tree growth and the sod was becoming thin, while the protected area had some tree growth and a fair sod.

The tree growth here was predominantly elm, chiefly white elm, with only a few cherries, wild apples, and hawthorns, totalling perhaps 100 stems per acre. There was no ailanthus in this area.

One portion of this area had the banks piled closer so that the gullies between them were much shallower and the area some-what less rugged. Here the elms were more numerous, possibly 150-200 per acre, but they were restricted to the bottoms of the gullies, and there was no tree growth on the upper third of each bank. There was a definite indication that with a reduction in slope and an increase in moisture there should be an increase in tree species.

Artificial planting of spoil banks:

A number of plantations of black locust were examined in this region, all of which could be classified as failures due to the locust borer (Cyllene robinia). In most cases, no merchantable posts were produced, and breakage and mortality were high in all cases. Very little reproduction of other tree species was found under these plantings, although locust sprouts were usually common.

Only one planting of pine (red pine in this case) on spoil banks is known in either Harrison, Jefferson or Belmont County, and it is young (planted in 1937) and planted on an outside bank. Survival is good and growth average, but the trees are too young to warrant any final decision.

Conclusions:

The two areas examined intensively and others less carefully, and observations made on other occasions in connection with a survey of forest plantations, lead me to make the following tentative conclusions:

Natural seeding of the spoil banks in their present steep condition is going to be unsatisfactory in anything less than 50-100 years. This is due apparently to the lack of moisture as well as fertility, and these conditions will change very slowly.

Artificial planting of the areas is suggested, but past results with locust have not been successful and the predominance of limestone in the soil may preclude the success of conifers. Conclusions cannot be drawn as to this as yet.

Leveling of the areas somewhat to increase the water penetration will likely increase the likelihood of tree growth. This is important too from the viewpoint of logging the areas if and when normal forests are established.

Natural leveling is not taking place. Slopes as steep as 100 per cent are not washing noticeably and no gullies were seen which were caused by erosion."

Wild Life and Recreation

Conservationists recognize the opportunities which some strip-mined lands hold for development as wild life and recreational areas. Interest in this respect naturally centers in those areas where relatively large blocks of land have been strip-mined as in Harrison and Jefferson counties.

Wild life and recreation can be appropriately associated with reforestation which accomplishes the threefold purpose of rebuilding a topsoil, acting as a nurse crop for future wood production even if the first planting can not be so utilized, and supplying the cover and food necessary for wild life. Developments up to the present time have demonstrated that wild animals native to eastern Ohio thrive in a spoil-bank habitat when a vegetative cover of herbaceous and woody plants has developed to afford food and shelter. In respect to the food supply it can also be suggested that some experimental work is needed to demonstrate what plants can be used to best advantage. The ease with which sweet clover can be grown on some spoil banks indicates that possibly a combination of leguminous plants would supply a constant source of food for both animals and birds.

In several cases landowners have stocked with fish the waters accumulated in strip-mine pits. The success of this depends upon several factors:

(1) Some circulation of water is desirable to keep down the concentration of minerals seeping from the coal vein; also, the coal vein must be completely covered with water to prevent oxidation of sulphur or other toxic elements.

(2) Covering the vein completely with earth halts undesirable seepage.

(3) A certain amount of vegetation growing in the water is necessary to sustain other forms of aquatic life.

(4) As a rule mine pits near the bottom of hills afford better water supply and offer better chances of success with fish than those located near the hilltops. Compared with the potential capacity, the present fishing facilities furnished by stocked mine pits are relatively unimportant. In Table 14 a classification is given of mine-pit waters in respect to their apparent suitability as a habitat for fish. It is interesting that such waters were present on about one-half of the strip-mined tracts and that one-half the ponds contained water that was reasonably fresh.

Table 14.- NUMBER AND CONDITION OF STRIP-MINE PONDS, 76 FARMS, COLUMBIANA, HARRISON AND JEFFERSON COUNTIES, 1940

Number of ponds	35	Number of ponds	35
Not suitable for fish at present	17	Water toxic or stagnant	17
Suitable for fish but not stocked	12	Water fresh seasonally	4
Stocked with fish	6	Water fresh (spring fed)	14

Fire control is needed.- Some farmers consider it inadvisable to go to the trouble and expense of developing a heavy vegetative cover on spoil banks as a process of reclamation because of frequent damage by fires. In their view the vegetation had better be pastured than burned off. Uncontrolled hunting and trespassing by irresponsible persons is an important factor in this situation. Fire control is unquestionably an essential feature of any comprehensive plan of reclamation of strip-mined areas.

The extent to which all strip-mined lands can be utilized for forestry, wild life, and recreation is as yet largely undetermined. No practical doubt exists that such uses are feasible where large holdings of land have been mined out and the unmined portions of such tracts also abandoned for agricultural use. In such instances no competive uses bar the development of reforestation and wild life. Public ownership in the general interest of the community appears a satisfactory solution under the above circumstances in order to obtain effective reforestation and conservation and the greatest benefit to the most people. Some tracts have been acquired by individuals and clubs for use as private recreational areas from which the public is excluded.

On the other hand, where the unmined part of the land is still being used for agriculture, private ownership will persist and the process of reclamation is influenced and complicated by the uses of the adjacent unmined land. Individual owners often are interested in converting mine pits into fish ponds and in reforesting of spoil banks as some have done, which indicates that private efforts at reclamation on small tracts would more or less parallel reclamation developments on larger tracts. But the need for pasture, the lack of capital, etc., retards reclamation measures by individual farmers; particularly when the present owner-occupants have bought strip-mined tracts after mining operations have been terminated. Some such owners have indicated a willingness to cooperate with public agencies in a program of reclamation. This raises the question of how reclamation should be achieved.

Several methods intended to speed the process of reclamation have been suggested: (1) Require strip-mine operators to level the land after the coal is removed. The objections to complete leveling have already been enumerated. (2)Require strip-mine operators to reforest at least as much land as has been strip mined. This would not necessarily be the mined-out land but preferably land at least adjacent to the spoil banks. As a practical matter, the unmined land will give a greater immediate return than the spoil banks for a given expenditure and should receive perhaps a major share of the reclamation effort. (3) Collection of a small tax, perhaps one cent per ton of coal mined, and use of the proceeds by the State in the reclamation work.

The above suggestions raise some important questions of public policy. In the first place, should land spoilation by strip mining be singled out for special attention when the future productive capacity of thousands of acres of land is being destroyed by methods of agriculture which create excessive erosion and land abandonment or when the ruthless cutting of timber may terminate income for generations? These three examples of exploitation differ in degree rather than in kind. Strip mining is the more spectacular and therefore attracts more attention and concern. Strip mining converts a natural resource into a large amount of usable wealth, $5,000 to $10,000 or more gross for each acre torn up. The royalty paid to land owners is roughly a measure of the economic, or exchange value, of the land's contribution to the total; this royalty will range approximately from $150 up to $1,500 per acre. Viewed from the standpoint of the general social good, land which has yielded this much wealth has earned a rest of 50 to 100 years before

society can justly say that it is an unprofitable burden which should be avoided. The above line of reasoning is contingent on the assumption that the benefits are realized by society, not confined to a few individuals and not dissipated but added to the aggregate fund of capital which society has accumulated through the years.

The real burden growing out of strip mining falls on the individual and the community after the land is torn up. This raises a question of indirect costs, social costs for which there is no well defined monetary measure. But here again it need be pointed out that destruction of the topsoil by erosion when wise use would save it or the complete cutting of timber instead of selective cutting, is creating the same problem in the same communities affected by strip mining.

But the argument can also be raised: Do two (or three) wrongs make a right? Each land-use problem has its appropriate solution or method of attack. Therefore, the problem of reclamation of strip-mined lands should be attacked by methods which offer some opportunity for success, leaving the other above mentioned difficulties to be met by devices which are already functioning to develop more satisfactory utilization and conservation of our land resources. The above discussion is intended to point out some pros and cons of a situation which need be met by the development of an appropriate public policy through the crystallization of public opinion.

SUMMARY AND CONCLUSIONS

Since 1913, coal has been strip-mined at some time or other in 24 Ohio counties. In 1939, 19 percent of all coal produced in Ohio was strip mined, and 90 percent of this amount came from seven counties. In descending order of production, these were Jefferson, Harrison, Stark, Columbiana, Mahoning, Tuscarawas, and Carroll. Jefferson and Harrison produced one-half of the State total.

From the standpoint of land use, present and future, the ultimate extent of strip mining is of prime importance, because conventional uses of the land surface are terminated and the uses of adjacent areas are affected. In the six counties producing the most strip-mined coal in 1939, it was determined that over 20,000 acres have been leased for stripping in the past 20 years, and that nearly 42,000 acres are owned in fee simple by mining companies, partly for stripping and partly for underground mining. Since only about one-fourth of the average tract is strip-mined, it is estimated that 7,800 acres have been mined out and that eventually a minimum of 13,000 and a maximum of 18,000 acres will be stripped. About one-half this total will be in a nearly contiguous area in Jefferson and Harrison counties; the other half is scattered over so much territory that no individual community will be so definitely affected.

The effects of strip mining on the tax system are twofold: First there is a period of expansion due to the tax yield from increased coal valuations, machinery, and equipment. Second, when the coal is exhausted, valuations of land will decrease so that local government will not benefit much from

taxes on strip-mined land, and tax delinquency will increase because some tracts will yield little or no current income. The second effect is now operating to some extent. Some 10,000 acres of coal lands in Harrison County showed a 53 percent loss in tax valuation from 1918 to 1937, as compared with a loss of 28 percent on all rural lands in the county. In Jefferson, over 9,000 acres of coal lands lost 62 percent; all rural land, 13 percent. Serious tax delinquency has not developed so far in strip-mined areas.

The utilization of strip-mined tracts of land forms a variable pattern depending on the extent of stripping; the location, quality, and topography of the unmined land; and whether or not the spoil banks seriously isolate unmined parts of the tract. Some full-time farms remain full-time farms; some are reduced to part-time farms; some are used for residential purposes only; and on some, all conventional uses are abandoned. Some modifications of the pattern are: the consolidation of strip-mined tracts with adjacent tracts, subdivision into small tracts for residential purposes or part-time farms, and, in a few instances, purchase or lease of the land for recreational purposes. Where agricultural use is abandoned, reforestation of unmined land and spoil banks has occurred in some places. Some mine pits are utilized as fishponds.

It was found that the occupants of strip-mined tracts differed widely in their degree of dependence on the land. Of the heads of such households, 41 percent were farm operators, as a principal occupation; 26 percent miners; 17 percent industrial workers; 6 percent laborers; 4 percent truck and bus drivers; and 6 percent were dependent on work relief. Strip mining is but one factor in this situation, because an estimated 75 percent of strip-mined land is in areas poorly adapted to agriculture.

Strip mining contributes to a period of instability in community life, because persons who lease or sell land for strip mining often move to new locations and are replaced to some extent by persons having more interest in industry and mining than in agriculture.

Some distinct physical limitations apply to the future use of spoil banks, because the land surface is so rough and broken. The depth of mining ranges from a minimum of about 10 to a maximum of about 70 feet. The deeper the mining, the steeper the spoil banks, which occasionally have a slope of 100 percent and often stabilize after slipping and settling to a slope of 60 percent. This slope is too steep for satisfactory permanent use as pasture, and forest production for commercial uses would encounter excessive logging costs.

The character of the subsoil on or near the surface of spoil banks determines the rapidity with which a new vegetative cover develops and starts the formation of a topsoil. In general, where the No. 8 vein of coal is strip mined, an abundant supply of calcium and a fair supply of phosphorus and potash are present. Spoil banks from all other veins of coal strip mined in eastern Ohio are usually low in phosphorus and potash and with a few exceptions are low in calcium. The most extensive contiguous areas strip mined are No. 8 coal.

Complete leveling of spoil banks is very costly and cannot be justified except for residential or urban purposes based on site value. The limited amount of complete leveling which has been done or contracted for indicates that the costs will usually range from $150 per acre to $600 per acre or more. Complete leveling to the original topography is conducive to serious erosion on hillsides. Experimental work on partial leveling is needed to determine whether it also is too costly when measured by reclamation benefits.

Three uses for spoil banks in eastern Ohio have been developed sufficiently to indicate some possible methods of utilization. On tracts still occupied and with some unmined land still used for agricultural purposes, it was found that spoil banks were pastured in about one-third of the tracts. Most pasturing is on spoil banks which have developed a cover of sweet clover, which in time is usually followed by a thin stand of bluegrass. The amount of forage produced ranges from abundant to very scanty, depending on the quality of soil and methods of management. As a general rule, pasturing spoil banks retards the development of a topsoil and is purely an exploitative process, as the land is so steep and broken as to prevent pasture-management practices such as mowing and fertilization.

Because of the extremely rough topography, spoil banks are better adapted to growing trees than pasture, and a forest cover aids in developing a topsoil. Past results indicate that the first forest growth on spoil banks can hardly be counted on to produce a crop of marketable timber but will serve to fit the land for climax species of more value. In the meantime, the cover of herbaceous and woody plants affords food and shelter for wild animals and birds.

Spoil banks with a well developed vegetative cover are a sufficiently favorable habitat for wild life to be considered as desirable recreational areas. Also, mine pits filled with fresh water are suitable for fish. Use of strip-mined land to supply hunting and fishing does not conflict with reforestation and these companion uses appear most suitable.

When in large contiguous holdings, strip-mined lands could be advantageously managed as publicly owned recreational areas. Small isolated holdings can be used in the same manner by individuals. A plan for reforestation of spoil banks and adjacent unmined land not suited to agriculture is needed in order to augment the dwindling land resources of the communities where strip mining exists.

It should be recognized that strip mining is but one of several causes of the depleted land resources in these areas. Soil erosion and depletion caused by poorly adapted methods of agriculture and the clean cutting of timber on lands suitable only for forest production have caused the income-producing capacity of the land to be destroyed on more acres than has strip mining. These difficulties each need to be met by an appropriate method of attack, which can be carried into effect only after a suitable public policy has been developed by the crystallization of public opinion.

Appendix Table 1.- PRODUCTION OF COAL BY STRIP MINING, INDIVIDUAL COUNTIES, OHIO, 1914-1939

(Tons of Coal Produced)

County	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
Carroll	4,477	----	----	1,256	----	----	----	3,500	----	----
Jefferson	136,969	268,285	429,110	767,845	1,807,283	890,573	1,623,948	446,220	1,046,221	986,153
Tuscarawas	----	23,449	36,830	44,238	24,360	148,950	353,212	52,101	204,057	85,403
Harrison	----	----	67,213	286,987	487,665	404,977	665,627	441,090	1,328,510	1,093,905
Columbiana	----	----	----	341	22,016	20,628	47,451	43,838	89,529	179,531
Guernsey	----	----	----	15,451	93,720	60,951	86,206	60,250	15,610	----
Jackson	----	----	----	1,457	4,055	110	----	----	----	----
Muskingum	----	----	----	100	35,827	33,411	133,193	19,449	85,929	74,645
Perry	----	----	----	103,090	254,130	263,640	619,542	376,187	293,539	431,803
Stark	----	----	----	4,602	1,136	25,205	1,150	655	1,149	----
Belmont	----	----	----	----	8,732	----	116,844	16,398	56,629	93,246
Mahoning	----	----	----	----	----	----	1,400	----	----	----
Wayne	----	----	----	----	----	----	----	----	----	----
Vinton	----	----	----	----	----	----	10,200	----	----	----
Hocking	----	----	----	----	----	----	----	----	----	----
Athens	----	----	----	200	----	----	----	----	----	----
Total	141,446	291,734	533,153	1,225,967	2,798,924	1,848,445	3,658,773	1,460,092	3,121,173	2,944,686

PRODUCTION OF COAL BY STRIP MINING, INDIVIDUAL COUNTIES, OHIO, 1914-1939
(Tons of Coal Produced)

County	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Carroll	47,756	82,398	32,669	11,042	----	----	----	3,745	----	5,294
Jefferson	498,189	431,975	623,223	797,522	684,059	459,717	122,993	77,579	112,191	18,804
Tuscarawas	39,232	35,653	15,479	16,909	24,231	25,658	28,063	28,774	9,528	12,822
Harrison	1,377,284	1,930,525	1,522,567	1,469,206	1,294,859	1,182,128	887,439	682,757	534,490	731,544
Columbiana	49,179	----	----	----	----	----	----	----	----	9,300
Guernsey	----	----	12,600	20,212	----	----	----	----	----	----
Muskingum	83,650	42,293	----	----	----	4,295	92,932	140,400	127,850	141,050
Jackson	----	247	----	----	----	----	----	----	----	43,348
Perry	296,364	38,870	122,040	13,304	13,480	95,147	10,316	6,626	----	26,554
Stark	5,337	15,637	13,202	16,427	11,267	7,043	11,288	7,331	4,919	3,538
Belmont	9,456	----	----	----	----	----	----	----	----	----
Mahoning	----	----	----	----	----	----	347	300	----	5,496
Wayne	1,488	----	----	----	----	----	----	----	----	----
Vinton	----	----	----	130	----	----	----	----	----	1,686
Hocking	----	23,781	15,878	----	----	----	1,561	750	----	----
Athens	----	----	107,650	42,127	9,103	5,159	----	----	----	----
Holmes	----	----	----	----	----	----	----	1,483	1,761	----
Coshocton	----	----	----	----	----	----	----	----	----	7,500
Medina	----	----	----	----	----	----	----	----	----	1,663
Total	2,407,935	2,601,379	2,465,308	2,386,879	2,036,999	1,779,147	1,154,939	949,745	790,739	1,008,599

PRODUCTION OF COAL BY STRIP MINING, INDIVIDUAL COUNTIES, OHIO, 1914-1939

(Tons of Coal Produced)

County	1934	1935	1936	1937	1938	1939
Gallia	----	----	----	----	----	20,834
Carroll	2,747	5,740	6,634	26,852	62,082	117,064
Jefferson	91,573	617,895	862,334	991,471	1,220,940	1,242,348
Tuscarawas	12,923	17,070	31,847	72,855	45,446	212,254
Harrison	592,052	691,916	640,699	524,755	246,093	632,104
Columbiana	27,878	125,777	262,337	120,310	132,852	394,363
Guernsey	----	----	----	----	----	----
Jackson	90,240	188,785	97,610	76,085	80,045	5,397
Muskingum	129,148	160,313	160,700	68,042	67,280	93,125
Perry	37,930	13,330	620	----	12,014	23,910
Stark	54,958	117,820	185,266	196,338	238,707	436,599
Belmont	----	----	----	----	----	69,344
Mahoning	----	----	----	65,935	159,539	358,402
Wayne	----	3,373	3,451	2,187	----	----
Vinton	86,720	59,348	54,364	51,774	33,047	75,750
Hocking	700	9,201	7,690	22,166	8,275	25,694
Athens	----	----	----	----	----	----
Holmes	5,169	22,389	12,835	4,243	5,801	4,208
Coshocton	7,161	21,324	14,661	12,423	20,854	13,691
Medina	2,254	----	----	----	----	----
Lawrence	----	----	824	1,064	707	969
Washington	----	----	128	----	----	----
Portage	----	----	----	----	4,120	33,426
Morgan	----	----	----	----	186	----
Total	1,141,453	2,054,781	2,342,000	2,236,490	2,399,390	3,759,482*

* Preliminary

Source: Ohio Department of Industrial Relations.